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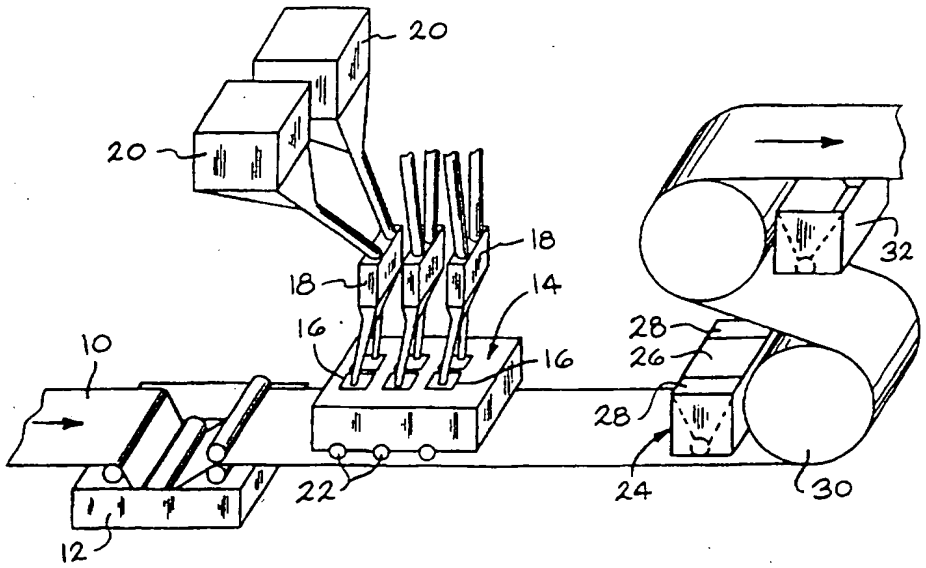

(57) Abstract

A roofing product includes a base sheet (10), a coating of an adhesive composition (52) on the base sheet, and a surface layer (44) of granules adhered to the coating (52), the roofing product including a tab portion (38) which is normally exposed on a roof, where the surface layer of the tab portion (38) includes naturally colored rock granules alone or in combinaison with artificially colored rock granules. In another embodiment, the surface layer of the tab portion (68) includes a blend of at least there different kinds of granules selected, at least one of which is naturally colored rock granules. Preferably the granules have a particle size from about 2.0 mm to about 0.3 mm.

ASPHALT ROOFING PRODUCTS SURFACED WITH NATURALLY COLORED ROCK GRANULES

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation-in-part of U.S. Patent Application Serial No. 08/656,645, filed 31 May 1996.

TECHNICAL FIELD AND INDUSTRIAL APPLICABILITY OF THE INVENTION

This invention relates in general to roofing products such as shingles, laminated shingles and roll roofing. More specifically, the invention relates to roofing products having a protective and ornamental surface layer including naturally colored rock granules, and is useful in the production of asphalt shingles, laminated shingles or roll roofing for use in residential or commercial roofing applications.

BACKGROUND OF THE INVENTION

A common method for manufacturing roofing products involves producing a continuous strip of roofing material and then cutting the material into individual shingles or into a suitable length to make roll roofing. In the production of the roofing material, a base sheet such as a glass fiber mat is typically passed through a coater containing molten asphalt. The asphalt saturates the base sheet and forms a tacky coating thereon. Subsequently, the coated base sheet is passed beneath one or more granule applicators which apply surface granules to portions of the sheet. Typically, the granules are dispensed from hoppers at a rate which can be controlled by making manual adjustments on the hoppers.

In the manufacture of colored shingles, two types of granules are often employed. Granules of relatively low cost are usually applied to the headlap portion of the shingle which is normally covered on the roof by an overlapping portion of an adjacent shingle, whereas colored granules of relatively higher cost are typically applied to the tab portion of the shingle which is normally exposed on the roof. To provide a color pattern of pleasing appearance on the tab or exposed portion, the colored granules are often provided in different colors. Usually a background color is formed of colored granules having a first color, and highlighted portions referred to as "blend drops" are formed of colored granules having a second color different from the first color.

The colored granules are usually produced by applying ceramic coating or paint to granules of mineral material, to control and provide consistency in performance and color of the granules. This approach allows granules of one color to be made consistently of mineral materials of different kinds from different sources. Unfortunately, the coloring process significantly increases the cost of the artificially colored rock granules in comparison to that of naturally colored rock granules. This adds to the direct manufacturing cost of roofing products made with the granules. The artificially colored rock granules also may experience problems such as fading, color shifting, spaulling, and loss of coating. Consequently, it would be desirable to be able to use naturally colored rock granules as at least a partial replacement for artificially colored rock granules on the exposed portion of roofing products.

SUMMARY OF THE INVENTION

There has now been developed a roofing product in which the surface layer of granules includes naturally colored rock granules. The naturally colored rock granules come in a variety of attractive colors. They avoid problems associated with artificially colored granules such as fading, color shifting, spaulling, and loss of coating. In a first embodiment of the invention, the naturally colored rock granules are blended with artificially colored rock granules on the exposed portion of the roofing products. Roofing products surfaced with the blend including naturally colored rock granules can result in having a more natural appearance than products surfaced with artificially colored mineral granules alone. The naturally colored rock granules provide significant cost savings versus artificially colored rock granules, and the naturally colored granules can be used in existing manufacturing equipment. However, some colors of naturally colored rock granules are not available in large enough quantities for making the most desirable color patterns of roofing products. Thus, to achieve superior appearance, cost savings, and assurance of a suitable granule supply, as well as other benefits not set forth below, the naturally colored rock granules are advantageously blended with artificially colored rock granules in amounts of from about 2% to about 98% by weight of the blend. Also, from the standpoint of color and overall appearance, it has been found preferable for producing some desirable color patterns to blend artificially colored mineral granules with the naturally colored rock granules.

In a second embodiment of the invention, the surface layer of the exposed portion comprises a blend of at least three different kinds of granules, at least two of

which are naturally colored rock granules that have a translucency of not greater than about 30%.

In a third embodiment, the naturally colored rock granules are provided with a preferred particle size distribution in which the granules are finer sized than conventional, artificially colored roofing granules. At least about 2% by weight of the granules of the tab portion are naturally colored rock granules, and the granules of the tab portion have a particle size from about 1.2 mm to about 0.3 mm. Granules having this preferred particle size distribution dramatically reduce shading problems on the roofing products. The finer size granules also require less weight of granules to cover the surface of the roofing products, so that the cost of the granules and the roofing products is reduced. The reduced weight of the granules allows the use of additional asphalt on the roofing products to achieve improved weatherability.

In a fourth embodiment of the invention, the surface layer of the exposed portion comprises naturally colored rock granules selected from shale, siltstone, limestone and dolomite having a particle size from about 2.0 mm to 0.3 mm.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a schematic perspective view of apparatus for applying granules onto the surface of an asphalt roofing product in accordance with the invention.

Figure 2 is a schematic plan view of a continuous strip of roofing material made in accordance with the invention, after cutting the strip but prior to separating it into individual shingles.

Figure 3 is a schematic perspective view of a shingle made in accordance with the invention.

Figure 4 is an enlarged schematic sectional view of a shingle taken along line 4-4 of Figure 3.

Figure 5 is a schematic perspective view of the two parts of a laminated shingle made in accordance with the invention.

Figure 6 is a schematic perspective view of the laminated shingle formed by joining the two shingle parts of Figure 5.

Figure 7 is a schematic perspective view of a laminated shingle including colored blend drop granules.

DETAILED DESCRIPTION AND PREFERRED EMBODIMENT OF THE INVENTION

Referring now to Figure 1, a base sheet 10 is provided to function as a reinforcing web for the roofing product. The base sheet is of a conventional type known for use in roofing products, such as a woven fabric or a nonwoven web of fibrous materials, for example, a nonwoven web or felt of glass fibers, synthetic organic fibers such as polyester fibers, natural organic fibers such as cellulose fibers, rag fibers, mineral fibers, mixtures of glass and synthetic fibers, or the like. Preferably the base sheet is a glass fiber mat.

The base sheet is passed through coater 12 containing a liquid adhesive such as a bituminous mixture, which is preferably molten asphalt. The hot, liquid asphalt saturates the base sheet and forms a tacky coating on both sides thereof. If desired, the asphalt can contain a filler material such as calcium carbonate (limestone), silica, rock fillers, fly ash, mica, or other fillers known for use in asphalt roofing products.

In an alternate embodiment of the invention, an outer layer of polymer-modified asphalt (not shown) is applied to the asphalt-coated base sheet. The resulting asphalt roofing product is heavier and has improved flexibility.

The base sheet with the tacky coating is then passed beneath a granule-dispensing device, preferably a granule blender 14, for the application of colored blend drop granules. The granules are applied as deposits on the upper surface of the tab portion of the sheet. The granules adhere to the coating and usually are partially embedded in the coating. The blender has a plurality of openings 16 formed therethrough. Hoppers 18 are positioned above the blender to feed blend drop granules into the openings. The hoppers are connected to storage bins 20 which contain the granules. The number of hoppers, storage bins and openings can be varied depending on the type of shingle product being manufactured. The rate, timing, size and shape of deposit of the blend drop granules can be adjusted by the blender. Blend compensators 22 are provided to coordinate the operation of the blender with the speed of the base sheet.

The base sheet is then passed beneath backfall hopper 24 for the application of colored background granules and headlap granules to the upper surface of the sheet. The backfall hopper has a center compartment 26 which deposits colored background granules on the base sheet. The colored background granules adhere to the asphalt coating on the tab portion of the roofing product, except on those parts already

covered with colored blend drop granules. Thus, the colored background granules form the background color of the tab portion of the base sheet. The backfall hopper also has a pair of side compartments 28 which deposit headlap granules on the headlap portion of the base sheet. Granules are fed to the different compartments by hoppers connected to storage bins (not shown).

Either blends of granules or single types of granules can be applied as colored blend drop granules, colored background granules, and headlap granules. The granules are usually blended before being supplied to the storage bins, but they can also be blended during the process of applying the granules to the base sheet. The types and blends of granules can be chosen depending on the particular shingle product being manufactured. The various types of granules applied to the base sheet will be discussed in more detail below.

Not all of the granules deposited on the coated base sheet adhere to the coating, particularly the colored background granules which are deposited on parts of the sheet already covered with colored blend drop granules. After deposition of the granules, the base sheet is turned around a drum 30 to invert the sheet and cause the non-adhered granules to drop off.

While the base sheet is inverted, a back dusting material such as sand or talc is applied to the lower surface of the base sheet. The back dusting material is supplied from a back dusting applicator 32. The base sheet coated with asphalt and surfaced with granules is then fed through a series of standard operations such as cooling and weighing. The sheet is then subjected to a cutting operation to form an asphalt roofing product of this invention. The sheet can be cut into individual shingles, into parts to make laminated shingles, or into a suitable length for roll roofing. The product is then packaged and shipped.

Figure 2 illustrates the strip of roofing material 34 made by the process after the cutting step but before separating the strip into individual shingles. Each strip is divided into two lanes of asphalt roofing shingles 36. A shingle 36 separated from the strip is shown in more detail in Figure 3. The shingle includes a tab portion 38 which comprises three tabs 40. The tabs are defined by cut-outs 42. However, it is recognized that the tab portion does not necessarily have cut-outs. The tab portion is normally exposed when the shingle is installed on a roof. A surface layer of granules is adhered to the coating on the tab portion. Background granules 44 provide the background color of

the tab portion, and deposits of blend drop granules 46 provide areas of highlighted color on the tab portion. Certain types of naturally colored rock granules and/or artificially colored mineral granules may be preferred for use as colored background granules or blend drop granules.

The shingle also includes a headlap portion 48. When rows of shingles are installed on a roof, the headlap portions of the shingles in each row are positioned beneath the tab portions of the shingles in an adjacent row. Thus, except for small strips of the headlap portion exposed through the cut-outs, the headlap portion of the shingle is normally covered when the shingle is installed on a roof. A surface layer of headlap granules 50 is adhered to the coating on the headlap portion.

As described above and illustrated in Figure 4, the shingle is comprised of several layers of material. The shingle includes a base sheet 10 of a glass fiber mat which functions as a reinforcing web for the shingle. The base sheet is saturated and coated with adhesive such as asphalt. An asphalt coating 52 is formed on the upper surface of the base sheet. A surface layer 44 of granules is adhered to the coating on the upper surface. A back coating 54 of asphalt is formed on the lower surface of the base sheet. A surface layer of back dusting material 56 such as sand is provided on the back coating.

While the production of the asphalt roofing product has been illustrated with respect to a preferred process, it will be understood that the product may be formed by any conventional manufacturing process. Although the illustrated process uses a strip of roofing material divided into two lanes of shingles, it is understood that the strip can also be a single lane or typically three or four lanes. The apparatus can be modified depending on the process, in a manner known to persons skilled in the art.

Figures 5 and 6 illustrate a preferred laminated asphalt shingle 58 in accordance with this invention. The laminated shingle is comprised of two parts, an overlay 60 and an underlay 62. The overlay includes a headlap portion 64 having a surface layer of headlap granules 66. The overlay further includes a tab portion 68 comprising four irregularly shaped tabs 70 in a sawtooth pattern. The tabs are defined by cutouts 72. The tab portion has a surface layer of colored background granules 74. The underlay 62 is adapted for positioning beneath the tab portion of the overlay. It is secured to the lower surface of the tab portion by adhesive or other means. The underlay has a surface layer of colored background granules 76. When the underlay 62 and overlay 60 are secured together as shown in Figure 6, exposed portions 78 of the underlay can be

seen through the cut-outs of the overlay. Usually the colored background granules 74 of the tab portion are a different color from the colored background granules 76 of the underlay. The resulting laminated shingle has a very attractive color pattern and a three-dimensional appearance when installed on a roof.

Figure 7 illustrates another laminated asphalt shingle 80 having blend drop granules 82 deposited on the tab portion. The overlay has a surface layer of colored background granules 84, and the underlay has a surface layer of colored background granules 86.

In accordance with this invention, the granules used to surface the roofing products include naturally colored rock granules. The term "naturally colored rock granules" means rock granules or mineral granules that are colored in their natural state, not granules that are artificially colored. Specifically, the naturally colored rock granules are not painted or covered with a coating such as a ceramic material to impart color to the granules. However, the naturally colored rock granules can be covered with a coating to provide other beneficial properties to the granules. For example, additives such as a hydrophobic additive or a bonding enhancer can be applied to the natural rock granules. The term "colored" means all colors including black and white, and includes different shades of a color. The naturally colored rock granules are obtained by crushing natural rocks and/or minerals to a desired particle size according to any method known in the art. The granules can also be screened to adjust the particle size.

Advantageously, the naturally colored rock granules used in this invention have excellent aesthetic and protective properties so that they are well suited for use on the exposed portion of a roofing product. The naturally colored rock granules come in a wide range of natural colors. The granules are preferably uniform in color on a consistent basis. The good color properties of the granules allow for traditional as well as improved roof aesthetics. The granules can be used as the background color of the exposed tab portion, or they can be used as blend drop granules to provide highlighted portions of contrasting color.

The naturally colored rock granules can be used by themselves as the surface layer on the exposed tab portion of the roofing products. In a preferred embodiment of the invention, however, the naturally colored rock granules are blended with artificially colored mineral granules. As used herein, the term "blend" means only that both types of granules are present on the exposed portion of the roofing product; the

granules need not be intimately mixed or blended together. Accordingly, such blends include roofing products having one type of granule on a first portion of the exposed surface of the product and another type of granule on a second portion of the exposed surface, as well as those in which the two types of granules are intimately mixed. For example, such a blend would encompass a roofing product wherein the blend drop portion of the product is composed of artificially colored granules and the background portion is composed of naturally colored granules.

The blend of granules comprises, by weight: naturally colored rock granules in an amount within the range of from about 2% to about 98%, preferably from about 10% to about 98%, more preferably from about 20% to about 98%, more preferably from about 35% to about 98%, more preferably from about 50% to about 98%, and most preferably from about 70% to about 98%; and artificially colored mineral granules in an amount within the range of from about 2% to about 98%, preferably from about 2% to about 90%, more preferably from about 2% to about 80%, more preferably from about 2% to about 65%, more preferably from about 2% to about 50%, and most preferably from about 2% to about 30%.

The artificially colored mineral granules are obtained by crushing and screening natural rocks and/or minerals and then painting or coating the granules to impart a uniform color to the granules. Preferred artificially colored mineral granules are colored ceramic-coated mineral granules which are presently available from several different suppliers. Suitable granules include 3M Brand Roofing Granules available from Minnesota Mining and Manufacturing Co. of St. Paul, Minnesota, and ISP Brand Roofing Granules available from ISP Minerals Incorporated, Bound Brook, New Jersey. Other suitable granules are available from Bird and H.B. Reed.

As described above, the blend of granules advantageously includes from about 2% to about 98% naturally colored rock granules. Roofing products surfaced with the naturally colored rock granules can result in having a more natural appearance and a richer, truer color than products surfaced with 100% artificially colored mineral granules. Consumers may prefer the roofing products having naturally colored rock granules as being more environmentally friendly and natural, and less artificial. The naturally colored rock granules can be selected based on the type of rocks and/or the rock colors of a particular region of the country, so that the roofing products will have regional appeal. In addition, the naturally colored rock granules provide significant cost savings versus

artificially colored rock granules, and the granules can be used in existing manufacturing equipment.

The preferred blend of granules also includes at least about 2%, and preferably at least about 10% artificially colored rock granules. It has been found that some colors of naturally colored rock granules may not be available in large enough quantities for making the most desirable color patterns of commercial roofing products. For example, blue rocks are not found abundantly in nature, and most white natural rocks do not have the required opacity for good roofing granules. Thus, to achieve superior appearance, cost savings, and assurance of a suitable granule supply, the blend is advantageously provided with at least about 2% artificially colored rock granules. In addition, the use of this minimum amount of artificially colored rock granules helps to ensure that the appearance of the roofing products is at least as good as products made with 100% artificially colored rock granules. As discussed above, in many instances the use of a blend of artificially colored rock granules and naturally colored rock granules causes the roofing products to have a preferred more natural appearance.

From the standpoint of color and overall appearance, it has also been found that some color patterns of roofing products cannot be made with 100% naturally colored rock granules. Instead, at least a minimum amount of artificially colored rock granules must be blended with the naturally colored rock granules to achieve the desired color patterns. In some instances, from 1 to 4 different kinds of naturally colored rock granules are blended with from 1 to 4 different kinds of artificially colored rock granules to achieve the desire appearance. As used herein, different "kinds" of rock granules include both differences in color and/or differences in rock type. Different ranges of types and colors of granules can be used depending on the particular color pattern.

In a preferred embodiment of the invention, the granules are a blend of at least three different kinds of granules, naturally colored.

The following Table 1 discloses preferred blends of naturally colored rock granules and artificially colored mineral granules for making different shingle colors. The blends of granules provide a more natural look on the shingles than 100% artificially colored mineral granules.

Table 1

Shingle Color	Naturally Colored Rock Granules	Colored Ceramic-Coated Rock Granules
Gray with Red	Dark gray diabase 40-65%, pref. 53%; Light gray diabase 30-50%, pref. 41%	Red 5-15%, pref. 6%
Light Gray and White	Dark gray diabase 5-10%, pref. 5%; Light gray diabase 40-65%, pref. 50%	White 30-55%, pref. 45%
Green and White	Green greenstone 50-70%, pref. 59%	White 30-50%, pref. 41%
Green and Black	Dark gray diabase 30-50%, pref. 36%	Green 50-70%, pref. 64%

The following Table 2 discloses other preferred blends of naturally colored rock granules and artificially colored rock granules for making different shingle colors.

Table 2

Shingle Color	Naturally Colored Rock Granules	Colored Ceramic-Coated Rock Granules
Medium Gray	Dark gray diabase 60-80%, pref. 70%; Light gray diabase 5-15%, pref. 10%	Dark gray 10-30%, pref. 20%
Grayish Brown	Dark gray diabase 30-50%, pref. 36%; Light gray diabase 5-20%, pref. 14%	Taupe 20-35%, pref. 29%; Dark brown 15-30%, pref. 21%
Dark Brown	Brown rhyolite 45-60%, pref. 53%	Light and dark black 40-55%, pref. 47%
Reddish Brown	Brown rhyolite 30-50%, pref. 40%	Buff, light brown and red 50-70%, pref. 60%

Brown with Red	Brown rhyolite 25-45%, pref. 35%	Taupe, buff, and dark gray 55-75%, pref. 65%
Brownish Black	Brown rhyolite 50-65%, pref. 56%	Reddish brown, buff and dark gray 35-50%, pref. 44%
Brown	Brown rhyolite 40-60%, pref. 50%	Reddish brown, buff and dark gray 40-60%, pref. 50%

In the above blends, the colored ceramic-coated mineral granules can be 3M Brand Roofing Granules in standard 3M colors. The colors of the naturally colored rock granules are defined by their Hunter L, a*, and b* colors as measured by a Hunter Colorimeter. The Hunter color system is well known to persons skilled in the art. A complete technical description can be found in an article by R. S. Hunter, "Photoelectric Color Difference Meter", *J. of the Optical Soc. of Amer.*, 48, 985-95 (1958). The following Table 3 discloses the Hunter colors of some typical roofing shingles:

Table 3

Shingle Color	L	a*	b*
Dark Gray	15 - 30	-1.5 - 1	1 - 5
Light Gray	45 - 55	-1.5 - 0	1 - 2
Medium Gray	25 - 40	-1.5 - 2	2 - 10
Brown	20 - 30	2 - 4	4 - 7
Dark Brown	18 - 30	0 - 6	2 - 5
Green	35 - 50	-5 - 1	3 - 7
Dark Green	20 - 30	-5 - 1	0 - 5
Light Tan	35 - 45	5 - 10	15 - 20
Red	23 - 32	15 - 20	10 - 18
Black	15 - 35	- 0.5 - 1	0 - 1

The following Table 4 discloses the Hunter colors of some naturally colored rock granules:

Table 4

Granule Color	Rock Type	L	a*	b*
Green	greenstone	25 - 35	-12 - 0	2 - 8
Red	slate, shale	20 - 40	4 - 18	3 - 15
Buff	limestone, rhyolite	35 - 60	5 - 15	15 - 25
Brown	rhyolite	20 - 35	3 - 12	5 - 10
Gray	diabase	25 - 55	-2.5 - 2	3 - 5
White	limestone, dolomite	50 - 70	-2 - 0	0 - 5
Black	diabase, basalt	15 - 30	0 - 5	-2 - 2

In another embodiment of the invention, the granules used to surface the roofing product are provided with a preferred particle size distribution in which the granules are finer sized than conventional roofing granules. As discussed below, the granules can be 100% naturally colored rock granules, or they can be blends of naturally colored rock granules with some amounts of artificially colored mineral granules.

Preferably, the granules of the exposed tab portion have a particle size from about 1.2 mm to about 0.3 mm. More preferably, the granules have the particle size distribution shown in Table 5 as measured by U.S. Sieve Series according to ASTM Method No. D-451:

Table 5

Mesh No.	Screen Opening Size	Weight Percent of Granules	Preferred Wt. % of Granules
Retained on 16 Mesh	1.19 mm	10 - 20	14.00
Retained on 20 Mesh	0.84 mm	40 - 55	50.00
Retained on 30 Mesh	0.59 mm	20 - 35	28.00
Retained on 40 Mesh	0.42 mm	3 - 13	6.00
Pass Through 40 Mesh	----	0 - 2	1.00

The granules having the preferred particle size distribution provide several advantages over conventional roofing granules. When conventional roofing granules are processed for application onto a roofing product, large and small sized granules have a tendency to separate from one another. As a result, the granules are segregated on the surface of the roofing product into areas of large granules and areas of small granules. This causes a problem known as "shading" in which different areas of the roofing product have a different shade of color caused by the different granule size. Shading is generally not desirable on roofing products from an aesthetic standpoint. By using granules having

the above-defined particle size distribution, the average granule size is closer to the size of the smallest granules. This has been found to reduce the shading problem on roofing products, even when the granules undergo segregation during processing.

Another advantage is that the finer sized granules require less weight of granules to cover the surface of the roofing products. As a result, the cost of the granules and the roofing products is reduced. Because roofing products are sold at a standard weight according to applicable building codes, the reduced weight of the granules allows the use of additional asphalt on the roofing products. The increased asphalt is expected to improve the weathering ability of the roofing products.

A common problem with roofing products is that the roofing granules tend to come loose from the asphalt, for example in a bundle of roofing shingles prior to use. Advantageously, the finer sized roofing granules of this invention may be less prone to coming loose from the asphalt of the roofing product.

Roofing products in accordance with this invention can be made using 100% naturally colored rock granules as well as blends of naturally colored rock granules and artificially colored rock granules. However, certain properties of the naturally colored rock granules are significant for providing good properties in roofing products, whether the naturally colored rock granules are used alone or in blends. For example, the chemical composition of the rock is important. The chemical composition controls the constituent mineralogy and color of the rock, and affects the weatherability of the rock, the granules shape, and the resistance of the rock to ultraviolet light. One of the basic functions of roofing granules is to protect the asphalt of the roofing product from the ultraviolet rays of the sun. The amount of ultraviolet rays transmitted through the natural rock granules is measured by a percent translucency. Preferably the natural rock granules used in the products of the invention have a translucency of not greater than about 30% according to ASTM Method D1866. Rocks that are high in iron, magnesium and/or calcium tend to be more UV resistant. Additionally, the grain size of the natural rock granules can also have a significant impact on the translucency. Generally, the smaller or finer the grain size, the more opaque, or less translucent, the granule. Consequently, the chemical composition is of lesser importance with finer grained rocks.

The hardness of the rock is another significant property for providing good roofing granules. The hardness of the rocks is determined by their mineralogy. Rocks containing a high content of silicates are usually relatively hard. One type of preferred

rock is a fine-grained aphanitic igneous rock with a silica content from about 47% to about 71% by weight. The term "aphanitic" means the grains are not clearly visible to the naked eye. Another preferred type of rock is medium- to coarse-grained phanevitic igneous rock with a silica content of about 41-50% by weight, such as diabase, gabbro and ultramafic rocks. Harder rocks are more resistant to breakdown during processing and handling. Preferably the natural rock granules have not more than about 3% breakdown during processing. Harder rocks also have improved weatherability. Preferably the natural rock granules have an average Mohs hardness greater than about 3, more preferably, greater than about 5. The natural rock granules must also be non-brittle so that they are not susceptible to breaking down in the raw material handling process, such as shipping and conveying through the plant process.

Examples of rocks having preferred chemical compositions, grain size and hardness are: (1) the igneous rocks having an average grain size less than about 0.3 mm such as basalt, andesite, bacite and rhyolite; (2) the igneous rocks having an average grain size greater than 0.3 mm such as diabase, gabbro and ultramafic rocks; (3) the metamorphic rocks having an average grain size less than about 2.0 mm such as amphibolite, greenstone, argillite, slate, hornfels, phyllite and gneiss; and (4) sedimentary rocks containing organic contaminants and clay minerals such as shale, siltstone, limestone and dolomite. In one preferred embodiment of the invention, the granules have a translucency of not greater than about 30% as a result of the constituent minerals having a high degree of secondary chemical alteration such as chloritization, sericitization or saussuritization. Other preferred natural rock granules comprise course grained plagioclase feldspars having an Ab or albite content from 0% to about 40% and an An or anorthite content from about 60% to 100%. These rocks are more UV resistant, and are darker and more desirable. The natural rock granules can also comprise course grained potassium feldspar mineral fragments.

The size of the natural rock granules is another important property. The size of the granule affects the appearance of the rock, with a larger rock granule giving more appearance of texture on the roofing product. In one embodiment of the invention, the rock granules are capable of screening to achieve size grade from No. 10 to No. 12 according to ASTM Method No. D-451. These sizes balance the texture of the granules with their coverage of the roofing product. In fine grained rocks, the granules may be composed of multiple grains and minerals. In coarse grained rocks, the granules will tend

to be single mineral grains when crushed. This may result in increased variability. Preferred fine grained rocks are the igneous rocks having an average grain size less than about 0.3 mm, such as basalt, andesite, dacite and rhyolite, the metamorphic rocks having an average grain size less than about 2.0 mm such as slate, phyllite, argillite, gneiss and greenstone; and sedimentary rocks such as shale, siltstone, limestone and dolomite. Preferred coarse grained rocks are the igneous rocks having an average grain size of from greater than about 0.3 mm to about 8.0 mm such as diabase and gabbro, and the metamorphic rocks having an average grain size greater than 2.0 mm such as amphibolite, greenstone and gneiss.

It has been found that the size of the natural rock granules also affects the color of the granules. The smaller the rock granule, the lighter the color of the base rock. As a result, the color of the rock granules can be adjusted by grinding the rock to different particle sizes. A roofing product can be provided with portions of lighter color and darker color by applying finer sized granules and larger sized granules to different portions of the product.

Another significant property of the natural rocks is their fracture or cleavage which determines the shape of the granules. Desired cleavage is flaky to prismatic. Cleavage in one direction results in a flat or flaky shape. Cleavage in two directions results in elongated rectangular blocks or cubes. The cleavage is mineralogy dependent for coarser grained rocks. The cleavage is structure dependent for metamorphic rocks. Preferred granules are predominantly minerals having basal or prismatic cleavage, and preferably are comprised of minerals having at least about 80% basal or prismatic cleavage. A basal cleavage means one prominent direction of cleavage and is found in metamorphic rocks such as slate, phyllite or schist. A prismatic cleavage has a blocky or cubic texture resulting from two prominent directions of cleavage at some angle relative to one another. The shape of the granules can be selected to improve other performance characteristics, such as to reduce shading problems. Round and cubic granules are good for eliminating shading. The shape of the granules will also affect how they pack together on the surface of the roofing product.

The density of the natural rock granules is another important property. The density of the granules affects shipping weight, shingle weight, and quantity of granules applied to a shingle. If the granules are less dense, more asphalt could be used on the roofing products to improve weatherability. A wide variety of different rocks are

available having high and low densities. A rock that is more mafic and/or has a lower silica content usually has a higher density. Preferably the average density of the natural rock granules is greater than about 2.5 g/cm^3.

Another significant property of the natural rock granules is their resistance to weathering. Rocks that have a high resistance to weathering are preferred so that the granules retain their protective properties and do not change color over the life of the roofing product (as much as 20-40 years for shingles). The granules must not fracture due to a freeze thaw mechanism or break apart. In general, rocks that are rich in quartz are very resistant to weathering, while rocks that are rich in iron or magnesium are easily weathered. The grain size and the cleavage also affect weathering. In general, preferred rocks are hard, silica-rich and fine grained. Preferred rocks include diabase, basalt, intermediate volcanics, argillite, slate, greenstones, and metabasalt. Chemically altered igneous and metamorphic rocks, such as by chloritization, sericitization, saussuritization or serpentinization, are believed to be very resistant to weathering. Preferred natural rock granules are resistant to weathering due to a high degree of secondary chemical weathering of the constituent silicate mineral.

Still another significant property of the natural rocks is their reflectance or absorption/conductance of incident light and heat. Preferred roofing granules provide radiation abatement, in that they reflect light and do not absorb and conduct heat.

Preferably each type of natural rock granule applied to a roofing product is uniform in color to provide a consistently good appearance, and specifically to reduce problems of shading. Also, preferably, the composition of each type of natural rock granule applied to a roofing product is relatively uniform.

The natural rock granules must be able to adhere to the coating asphalt. They should not be hygroscopic, because the absorption of moisture would loosen the bond between the granule and the asphalt. Artificially colored rock granules usually require the application of silicone and/or oils to obtain good adhesion to the asphalt. These materials are often not required for natural rock granules to obtain good adhesion, so that costs can be reduced and the granules are more environmentally friendly. The natural rock granules should not react chemically with the asphalt, to cause any significant changes in the granules or asphalt or to loosen the bond between the materials.

Certain color patterns of roofing products such as shingles have not previously been achieved by the use of 100% artificially colored rock granules. Preferred blends of naturally colored rock granules according to this invention will provide such color patterns. For example, shiny black colored shingles can be made using from about 20% to about 35% (preferably about 29%) dark gray diabase rock granules, and from about 65% to about 80% (preferably about 71%) shiny black coal slag granules. Green and black colored shingles can be made using from about 30% to about 50% (preferably about 36%) dark gray diabase rock granules, and from about 50% to about 70% (preferably about 64%) natural green greenstone rock granules.

Some kinds of naturally colored rock granules have different shades of color within the individual rock granules. This provides the capability of using fewer different kinds of rock granules to obtain different preferred blends of colors on the roofing products. Also, the different colors of an individual kind of rock can provide the effect of blend drops without requiring the use of different rocks. For example, a rock can be used that is various shades of gray to provide a blended appearance. Other rocks, such as rhyolite, come in several different colors such as brown and gray.

It has been found that various desired colors for roofing granules can be obtained by using natural rock granules having certain mineral contents. Although white colored rocks having sufficient opacity to be suitable for roofing granules are relatively difficult to find in nature, in one preferred embodiment, the granules have a natural white color due to a mineral composition comprising at least about 90% by weight calcium-rich limestone or dolomite. Similarly, it is relatively difficult to find suitable red colored rocks in nature. However, suitable granules can be naturally colored red due to a content of from about 40% to about 50% of potassium feldspar. Preferred red colored rocks are some igneous rocks including rhyolites, some metamorphic rocks such as slate, and sedimentary rocks such as shale and siltstone.

In another preferred embodiment, the granules have a natural dark color (e.g., black, dark green, dark gray, or dark brown) resulting from at least about 40% by weight ferromagnesian silicate mineral content. A preferred dark rock is basalt. The granules can also be naturally colored black due to at least about 80% by weight of the mineral group amphibole. Preferred rocks include high grade metamorphic rock, metamorphosed shale, and metamorphosed basalt. The granules can also be naturally

colored green as a result of chlorite alteration of the ferramagnesian minerals of the granules. Usually basalt metamorphoses to a greenstone.

Naturally colored rock granules also provide an advantage over artificially colored mineral granules in terms of temperature of the granules. During their manufacture, artificially colored mineral granules are heated to cure their coating. The granules remain hot during subsequent shipping and storage. If the granules are not allowed to cool sufficiently prior to their use, when they are applied to the roofing products, the hot granules sink into the asphalt excessively so that more granules are required to provide adequate coverage. Additionally, the temperature of the granules may also be non-uniform such that some sink into the asphalt more than others, resulting in a non-uniform appearance on the roofing product. In contrast, naturally colored rock granules are received cooler and do not need to be cooled prior to application to the roofing products so that they do not sink too far into the asphalt. As a result, fewer granules are required to provide good coverage of the roofing product, so that cost is reduced. Also, the appearance of the granules is more uniform on the surface.

The principle and mode of operation of this invention have been described in its preferred embodiment. However, it should be noted that this invention may be practiced otherwise than as specifically illustrated and described without departing from its scope.

CLAIMS

1. A roofing product comprising a base sheet, a coating of an adhesive composition on the base sheet, and a surface layer of granules adhered to the coating, the roofing product including a portion which is normally exposed on a roof, wherein the surface layer of the exposed portion comprises, by weight, from about 2% to about 98% naturally colored rock granules and from about 2% to about 98% artificially colored rock granules.

2. The roofing product of claim 1, wherein said adhesive composition comprises a bituminous mixture

3. The roofing product of claim 2, wherein said naturally colored rock granules have a translucency of not greater than about 30%.

4. The roofing product of claim 3, wherein said naturally colored rock granules have a Mohs hardness of greater than about 5.

5. The roofing product of claim 4, wherein the surface layer of the exposed portion comprises, by weight, from about 2% to about 50% naturally colored rock granules and from about 50% to about 98% artificially colored rock granules.

6. The roofing product of claim 5, wherein said naturally colored rock granules comprise igneous rock having an average grain size of less than about 0.3 mm.

7. The product of claim 6, wherein said naturally colored rock granules have a silica content of from about 47% to about 71% by weight.

8. The roofing product of claim 7, wherein said naturally colored granules are selected from the group consisting of basalt, andesite, dacite and rhyolite.

9. The roofing product of claim 8, wherein said naturally colored rock granules comprise at least about 40% by weight ferromagnesian mineral.

10. The roofing product of claim 8, wherein said naturally colored rock granules comprise from about 40% to 50% by weight potassium feldspar.

11. The roofing product of claim 8, wherein said naturally colored rock granules comprise minerals chemically altered by chloritization, sericitization, saussuritization or serpentinization.

12. The roofing product of claim 5, wherein said naturally colored rock granules comprise igneous rock having an average grain size of from greater than about 0.3 mm to about 8.0 mm.

13. The roofing product of claim 12, wherein said naturally colored rock granules have a silica content of from about 41% to about 50% by weight.

14. The roofing product of claim 13, wherein said naturally colored rock granules are selected from the group consisting of diabase, gabbro and ultramafic rocks.

15. The roofing product of claim 14, wherein said naturally colored rock granules comprise at least about 40% by weight ferromagnesian mineral.

16. The roofing product of claim 14, wherein said naturally colored rock granules comprise from about 40% to 50% by weight potassium feldspar.

17. The roofing product of claim 14, wherein said naturally colored rock granules comprise minerals chemically altered by chloritization, sericitization, saussuritization or serpentinization.

18. The roofing product of claim 14, wherein said naturally colored rock granules comprise plagioclase feldspar having an albite content less than about 40% by weight and an anorthite content greater than about 60% by weight.

19. The roofing product in claim 5, wherein said naturally colored rock granules comprise metamorphic rock having an average grain size of less than about 2.0 mm.

20. The roofing product of claim 19, wherein said naturally colored rock granules are selected from the group consisting of slate, phyllite, argillite, gneiss, hornfels, and greenstone.

21. The roofing product of claim 20, wherein said naturally colored rock granules comprise at least about 40% by weight ferromagnesian mineral.

22. The roofing product of claim 20, wherein said naturally colored rock granules comprise from about 40% to 50% by weight potassium feldspar.

23. The roofing product of claim 20, wherein said naturally colored rock granules comprise minerals chemically altered by chloritization, sericitization, saussuritization or serpentinization.

24. A roofing product comprising a base sheet, a coating of an adhesive composition on the base sheet, and a surface layer of granules adhered to the coating, the roofing product including a portion which is normally exposed on a roof, wherein the surface layer of the exposed portion comprises naturally colored rock granules selected

from the group consisting of shale, siltstone, limestone, and dolomite, said granules having a particle size of from about 0.3 mm to about 2.0 mm.

25. The roofing product of claim 24, wherein said naturally colored rock granules comprise greater than about 90% by weight limestone or dolomite.

26. The roofing product of claim 3, wherein said naturally colored rock granules have a particle size of from about 0.3 mm to about 1.2 mm.

27. The roofing product of claim 26, wherein the particle size distribution of said granules is such that, on a weight basis, 10-20% are retained on a 16 Mesh screen, 40-55% are retained on a 20 Mesh screen, 20-35% are retained on a 30 Mesh screen, 3-13% are retained on a 40 Mesh screen, and 0-2% pass through a 40 Mesh screen.

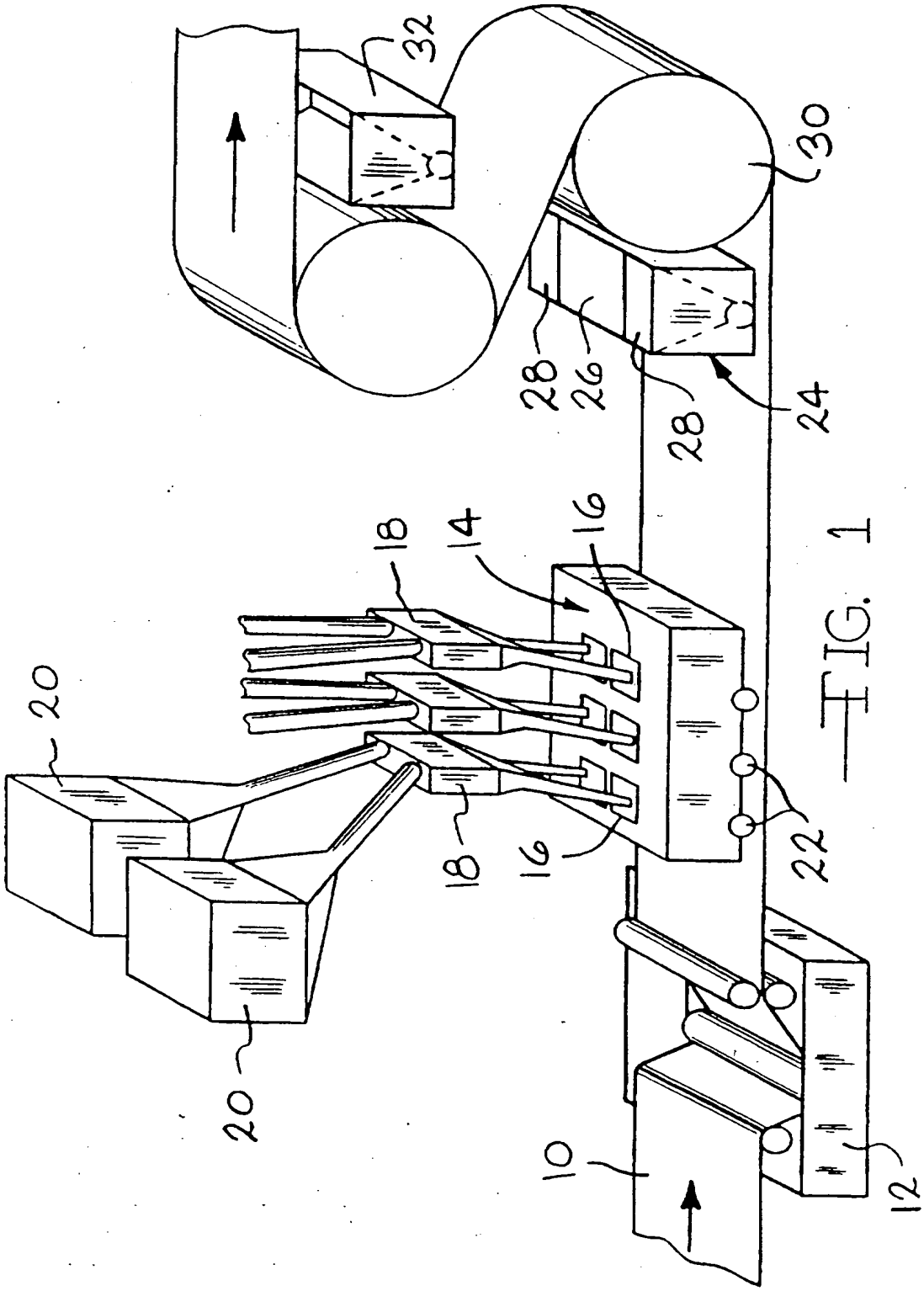

FIG. 1

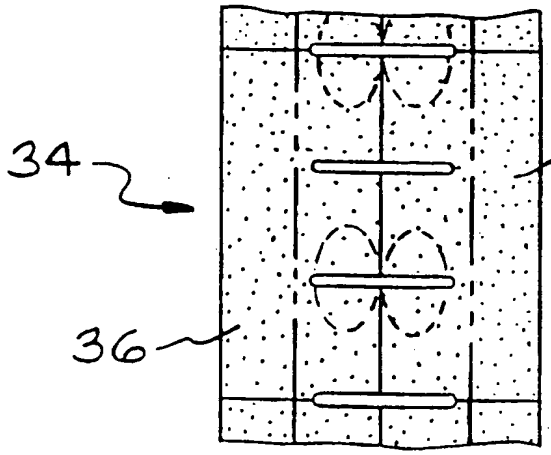

FIG. 2

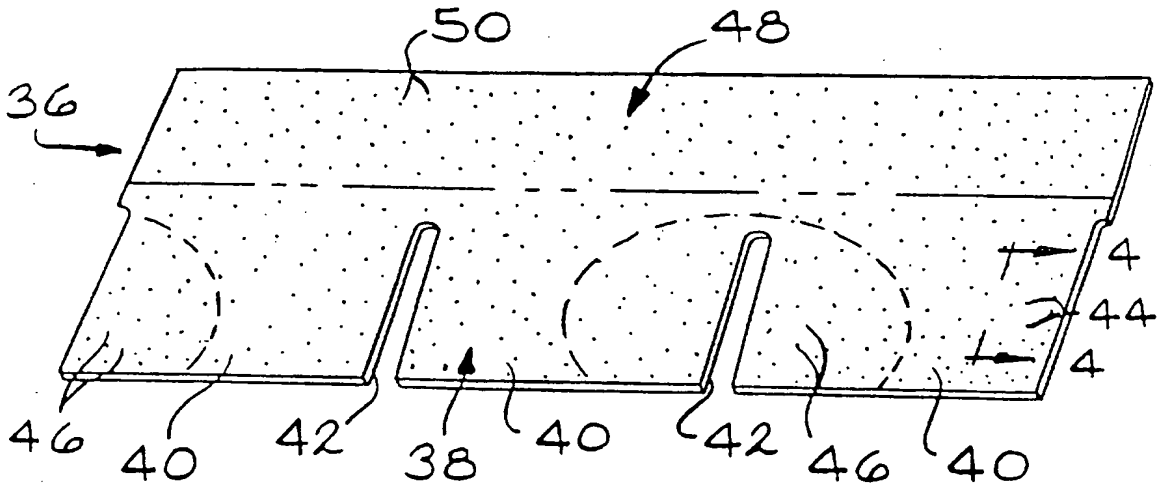

FIG. 3

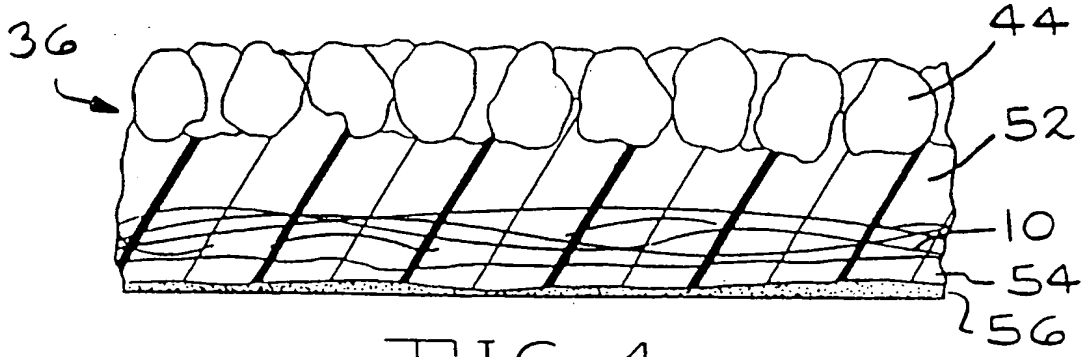

FIG. 4

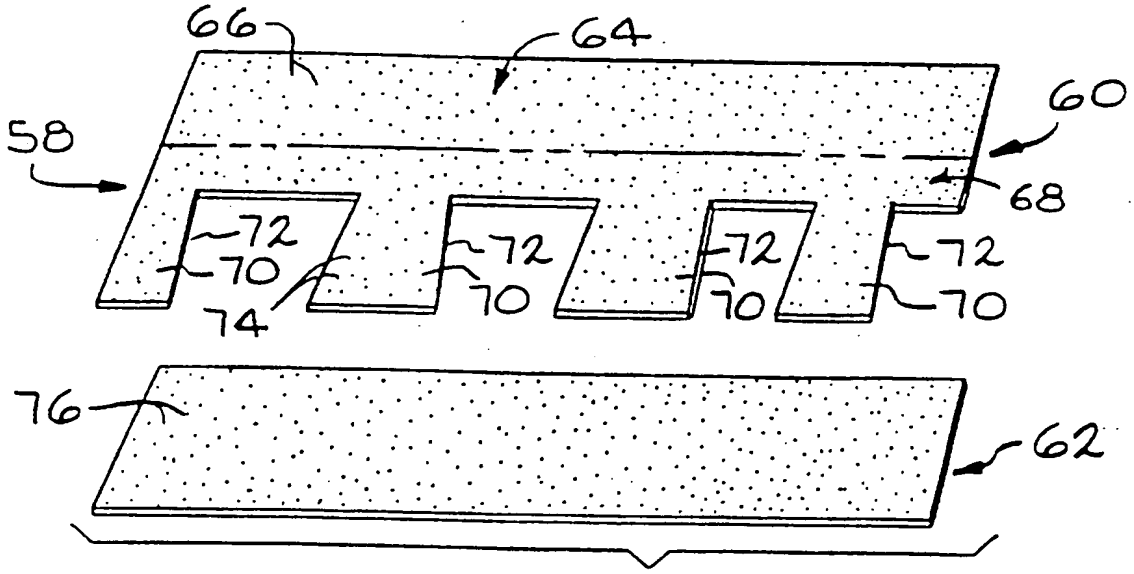

FIG. 5

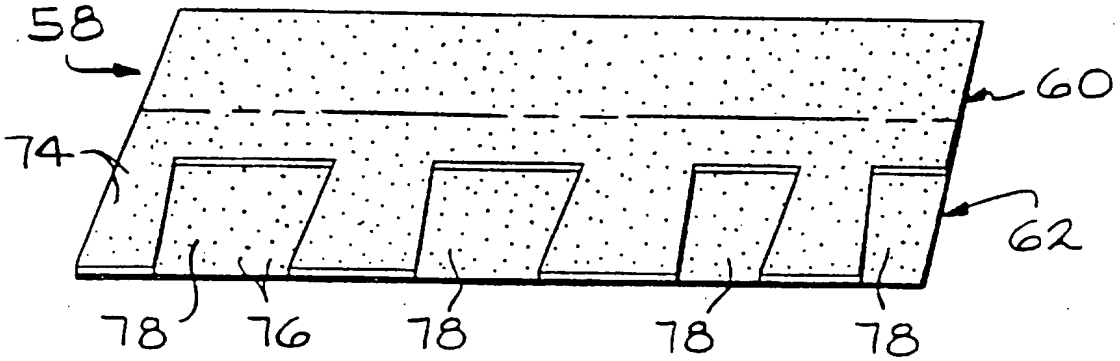

FIG. 6

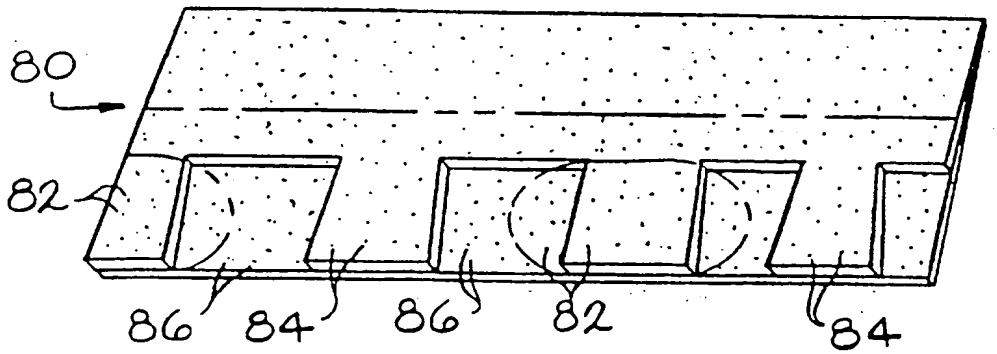

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/09137

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :E04D 1/00
US CL . 52/554
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 52/554, 523

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,181,361 A (Hannah et al) 26 January 1993 (26/01/93), see entire document	1-27
Y	US 5,094,058 A (Slocum) 10 March 1992 (10/03/92), see entire document	1-27

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 09 JULY 1997	Date of mailing of the international search report 18 JUL 1997
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer WYNN E. WOOD Telephone No. (703) 308-2168

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